BATHTUB AERODYNAMICS

by David and August Raspet

I. *Introduction*

During an all-too-frequent session in the bathtub on a cold, wintry Saturday evening the senior author occupied himself with a small plastic airplane model which he found on the side of the tub, instead of with a brush and soap. Attempting to glide this model under water, he noticed that the model stalled from a normal glide. By trimming the model with a few tacks stuck with soap into the nose, and thus perfecting its balance, the senior author noted that a surprisingly good slow-speed glide resulted.

Interestingly enough, this kind of underwater experiment provides a good study of slow-speed motions of airplanes. After many such fascinating experiments, the senior author and his father (the junior author) decided to write this article and thereby communicate the pleasure they obtained from this simple technique to their enthusiasts of aviation.

The nice thing about the technique that will be described is the ease with which it may be carried out. The very elegantly molded plastic models were up to now only for show. Now they can actually fly — under water. These flights are reasonably similiar to real flights in the air, in that stalls, spins, pitching of the nose and whip stalls may be done in slow-speed motion which can be closely followed by normal observation without expensive high-speed motion picture photography.

Not only can observations be made but also measurements of glide-angle and flying speed can easily be made. In addition, with simple means, it is possible to find out about the nature of the boundary layer (the thin layer of air that surrounds the surface of the whole plane), of the wing tip vortex, and of the influence of stall on the tip vortex and the nature of wing root interference.

In other words, modelers, here is an entertaining and instructive technique which requires only a simple plastic model and a bathtub. If you don't have a bathtub, go to your local swimming pool or to the ole swimmin' hole and conduct your underwater aerodynamics there.

II. *Models Available For Bathtub Aerodynamics*

Probably the cheapest models are those which can be bought for 10 cents at most dime stores. These are made by Renwal and other plastic toy manufacturers. For good performance these need considerable work, but they lend themselves to interesting changes. We have used the Spitfire and P-40 of this type. The span of the models is 4 inches.

Next in size and price come such models as Olin's Mooney Mite made to 1/40 scale having a span of 6½ inches. These sell for 25 cents. They require assembly but this is very easy. Other models such as Howard Pete are available from this manufacturer for the same price.

By far the most realistic models are the larger ones such as the F-51 made by Hawk. This model sells for 89 cents. Its span is 9½ inches. Also in this group is the Gruman F9F made by Aurora and selling for 59 cents. This firm also makes the F-90 which costs 89 cents. Its span is 10 inches.

For those fortunate enough to have some war surplus recognition models, we suggest the Gotha 242 glider as being an ideal performer. It has a 13¼ inch span and is a little big for the average bathtub, but it would be a fine size for a swimming pool. These recognition models sold for several dollars.

In the field of exact scale plastics, one will find the Allyn models of excellent quality. Their price runs from $1.79 to $2.79.

III. *Balancing and Stability Testing*

The 10-cent models require only a little weight up on the nose in order to achieve trimmed stable flight. We used one or two small tacks stuck into soft soap molded into the open bottom of the nose to get balance on these models.

The hollow-fuselage jobs such as the scale plastic planes, Mooney Mite, Howard Pete, P-51 and the others, require that the fuselage be filled with water. You must make absolutely sure, however, that there are no bubbles inside the model, for bubbles will move back and forth as the model

The Senior Author.

pitches, thereby changing the center of gravity and affecting the stability as badly as shifting ballast will in a large airplane. Quite a few test pilots have met with accidents due to shifting ballast.

When the model is completely free of bubbles it can be flown in the tub and its trim can be checked. Usually a little lead or a nail is needed in the nose or spinner to get longitudinal balance. The model will behave exactly as models in the air except that the flight will be very slow. If the model pitches its nose up and stalls, more weight is needed in the nose. When correct balance is obtained, a smooth, straight flight results.

On jet-type models the jet intakes need not be closed, for when the model is filled with water the water merely flows through the jets at slow speed.

On the recognition models it may be necessary to drill two holes (one on top and one on the bottom of the fuselage) to be sure of filling the fuselage with water. If some enterprising modelers wish to make tests at different wing loadings, it is possible to fill the fuselage with wax for low wing loading tests or with heavy liquids for heavier wing loadings.

If the model is balanced to a point where it is slightly tail heavy and is launched in a normal glide, the model will pull up to a stall; and if the model is perfectly symmetrical, it will recover by nosing down in a normal manner. However, if the model is slightly asymmetrical, it will not recover but fall off into a slow-motion spin. This is really a fascinating maneuver to observe.

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